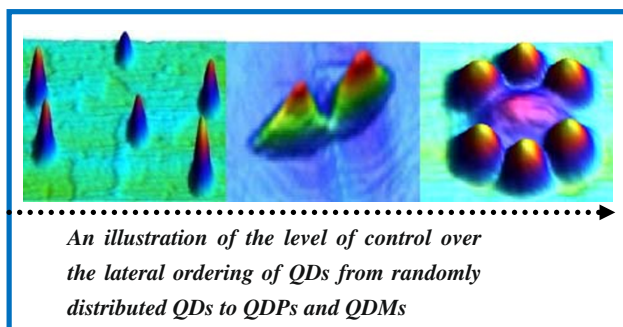


## Towards Quantum Computing

### A Hybrid Approach That Will Unleash a Plethora of New QD Nanostructures, Bringing Us a Step Further to Laterally Coupled QDs

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While the properties of individual quantum dots (QDs) are deemed attractive for applications in quantum computing, practically, they are insufficient. However, being able to group QDs to enable communication among them (quantum dot molecules—QDMs) is still extremely challenging although this field has been studied for about 20 years. Therefore, in an attempt to control the lateral ordering of QDs, researchers at the University of Arkansas have developed a simple hybrid technique to fabricate QD pairs (QDPs) and QDMs. This technique has shown promise and paves the way for investigating possible interactions between QDs, taking us one step further to realizing quantum computing.

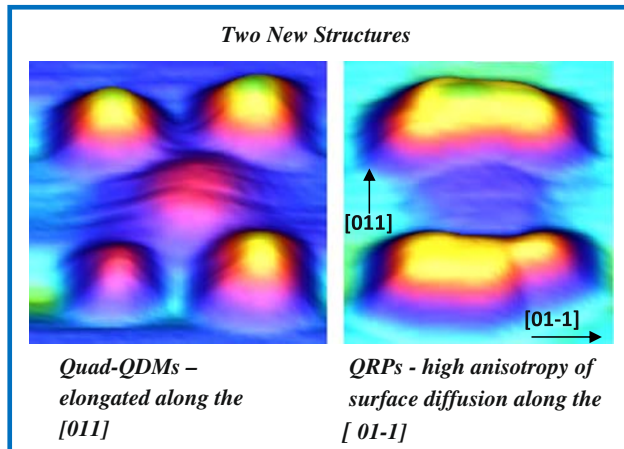


Kimberly Sablon, Zhiming Wang and Gregory Salamo (who leads the atom manipulation MRSEC facility at the University of Arkansas) and other co-authors have taken lateral ordering of QDs to a whole new level and have devoted much effort to controlling the configuration of QDMs. Their most recent findings were reported in an article entitled, “*Configuration control of quantum dot*

*molecules by droplet epitaxy*”, published in Applied Physics Letters in 2008. “Self-assembly of semiconductor nanostructures has been intensively investigated”, Sablon explains to Nanospotlight. “In fact, the stranski-krastanow (SK)-based growth approach, which is used in lattice-mismatch systems, has made it possible to achieve a vast range of structures with control over size and density but results in a random lateral spacing of QDs which can hinder the QD functionality as a qubit in quantum computing.” Therefore, an alternative growth approach, termed droplet epitaxy (DE), was developed and integrated with the SK method. According to the researchers, this method involved the crystallization of metal droplets on the surface, forming semiconductor nanostructures. This method is an intermediate step for creating the semiconductor nano-mound templates used for subsequent QD formation. “The approach has shown previous success in the fabrication of QDPs and has been a promising method for ordering QDs locally, forming QDPs as reported in the published article titled “*Self-organization of quantum-dot pairs by high-temperature droplet epitaxy*” in Nanoscale Research Letters in 2006”, says Sablon.

“The recently published article utilized droplet epitaxy, taking advantage of the anisotropic surface diffusion on GaAs (100) and the fact that QDs energetically favor high density step regions to fabricate QDMs” Sablon further explains her current research to Nanospotlight. “In the recent work, we thoroughly explored how and why these structures form in order to control the configuration to achieve quad-QDMs”, Sablon explains. “The investigation yielded two new types of semiconductor nanostructures, quad-QDMs elongated along the [011] due to strain-driven processes and quantum rod pairs (QRPs) due to higher

anisotropy of surface diffusion along the  $[01\bar{1}]$ ”, Sablon said.



The results demonstrated by Sablon and her colleagues are observed at a substrate temperature of 480 °C which is lower than previously reported experiments on QDMs (growth temperatures of 530 °C). “Although this temperature is lower than previous experiments, it is still categorized as high-temperature droplet epitaxy, which when compared to other droplet-related experiments that occur at about 200 °C, can result in novel nanostructures” says Sablon. “Currently, we are working towards controlling the position and size of the Ga droplets for more precise control over the position and size of QDs fabricated via this hybrid approach.”

Kimberly Annosha Sablon